PROC. ENTOMOL. SOC. WASH.
89(4), 1987, pp. 744–758

# REDESCRIPTION OF AN ERGOT BEETLE, *ACYLOMUS PUGETANUS* CASEY, WITH IMMATURE STAGES AND BIOLOGY (COLEOPTERA: PHALACRIDAE)

Warren E. Steiner, Jr. and Bhisham P. Singh

(WES) Department of Entomology, University of Maryland, College Park, Maryland 20742; (Present address: Department of Entomology, NHB-169, Smithsonian Institution, Washington, D.C. 20560); (BPS) Plant Protection and Quarantine, Animal and Plant Health Inspection Service, USDA, Federal Building, Hyattsville, Maryland 20782.

*Abstract.*—*Acylomus pugetanus* Casey (Coleoptera: Phalacridae) feeds on the toxic sclerotia of ergot (*Claviceps* spp.) on grains in North America. The biology and potential economic importance of the beetle as a control agent and vector of the fungus disease are discussed. Specimen data and distribution records are given. The adult, larval, and pupal stages are described and illustrated.

A species of *Acylomus* Sharp (Coleoptera: Phalacridae) has been associated with ergot fungi of grains in Michigan (Singh, 1981) and was thought to be undescribed. An earlier study, apparently concerning the same species, but unidentified by the authors, attempted to determine the effects of the beetles' feeding on sclerotial germination (Lambert and McIlveen, 1976). The species has now been identified as *Acylomus pugetanus* Casey. This species was described from a single specimen from Washington, but is now known to have a wide distribution across the northern United States, south to Arkansas and Virginia.

The beetle feeds on the sclerotia of ergot fungi (*Claviceps* spp.) which are known to contain a number of toxic alkaloids, some of which are related to the drug LSD (Bargar, 1931; Bove, 1970). The implication of this and other species of Phalacridae in the spread or biological control of ergot and smut diseases of grasses has created an interest in the group, but identification of the species with the existing literature is not possible. Studies to determine if the beetles have detoxification mechanisms and coevolutionary relationships with the fungi and grasses, also of great interest, could be carried out if *Acylomus* species can be recognized.

The North American species of *Acylomus* were studied by Casey (1916), who described all of the species presently known from the United States. The genus is primarily Neotropical, but some species occur northward to southern Canada. The group has not recently been studied systematically, and, as with most phalacrid beetles, the biology and larval stages of most members are unknown. *Acylomus pugetanus,* which has been shown to be of potential economic importance, is redescribed and illustrated in this paper. Its larva and pupa are also described, with information on life history. The larval stages and ways of life of *A. pugetanus* are thus far unique among the Phalacridae, and even aberrant among the members of the genus, being different from those recently associated with a few other adult *Acylomus* (Steiner, 1984). A key to the species of *Acylomus* will be presented in a

future review of North American *Acylomus* members.

### *Acylomus pugetanus* Casey

Description.—Length 1.6–2.1 mm; greatest width (at basal ¼ of elytra) 1.0–1.2 mm; greatest thickness (at metasternum) 0.6–0.7 mm. Body form oval, strongly convex dorsally, with head, pronotum and elytra forming a continuous oval outline in dorsal view; dorsal surface strongly shining, polished; coloration very dark brown to black dorsally, brown ventrally, with more darkly pigmented area across metasternum; appendages brown, femora darkened.

Head rounded, ½ as wide as pronotum, with eyes large; frons with surface finely, randomly punctate, black, becoming brownish very narrowly along clypeus; labrum light brown, setose; mandibles with sharp, bidentate apices; antennae setose, with 11 segments and a 3-segmented, elongate club with apical segment nearly as long as 2 preceding segments combined.

Pronotum 2× wider than long, widest basally, narrowly margined laterally, with fine, shallow, random punctures (each bearing a minute seta) and extremely fine, transversely strigulate microsculpture dorsally; prosternal process (Fig. 1A) abruptly truncate between front coxae, not extending posterior to them, with a sharp, shelflike edge bearing 5 small, posteriorly directed setae.

Elytron 2× longer than wide, with microstrigulate surface (Fig. 1C, D) as on pronotum; punctures in regular, alternating, longitudinal rows of larger and smaller size, shallow, crescentiform, each with a fine, decumbent seta; sutural stria well developed, reaching basal ⅕ of elytron.

Mesosternum well developed behind middle coxae, forming sharply angulate lobe behind each coxa (Fig. 1B) with mesal side slightly curved, distal side nearly straight. Metasternum, abdominal sterna and legs setose. Hind tibiae without any apparent sexual dimorphism, slender, gradually widening from base to middle, nearly parallel from middle to apex; truncation of apex slightly oblique. Hind tarsi with basal segment ½ as long as second; 3rd segment of intermediate length, narrow, with apex bilobed; 4th segment very small, appearing as basal part of 5th segment. Tarsal segments 1–3 with dense pubescence ventrally. Claws with apices slender, sharp; basal tooth broad, not pointed.

Male genitalia (Fig. 2a–d) with basal piece short, broad, arched dorsally, with 2 symmetrical "false parameres" at apex of each side of true parameres (which are fused into a single pointed apex); basal ring asymmetrical; dorsolateral struts slender, very weakly sclerotized, each with a heavily sclerotized protuberance near base; median dorsal strut short, pointed. Inner lining sclerite lightly sclerotized, membranous basally except lateral struts; apex broadly rounded, dorsoventrally flattened, with a slightly upturned edge in lateral view.

Parameres entirely fused into a small, conical sclerite hinged and movable between false parameres, with 2 pairs of long setae apicolaterally and one pair basoventrally.

Median lobe not heavily sclerotized; main sclerite with a broadly rounded, spoon shaped apex, narrow lateral rods, and a simple, flattened, somewhat asymmetrical base; internal sac with 2 apical, external, dorsolateral sclerites forming convergent, tonguelike lobes; system of internal sclerites well developed, with hook and crescent sclerites strongly sclerotized, pigmented; small toothlike spicules lining sac and sperm duct above hook sclerites, forming 2 dense lateral rows of longer, fine spicules immediately before internal sac sclerites; sperm duct with a globular brush of fine, hairlike spicules where duct narrows (usually adjacent to basal tip of main sclerite).

Variation.—There are occasionally 6 or 7 setae across the apex of the prosternal process rather than the usual number of 5. Also, the setae are easily broken off and in some specimens may appear to be entirely lack-

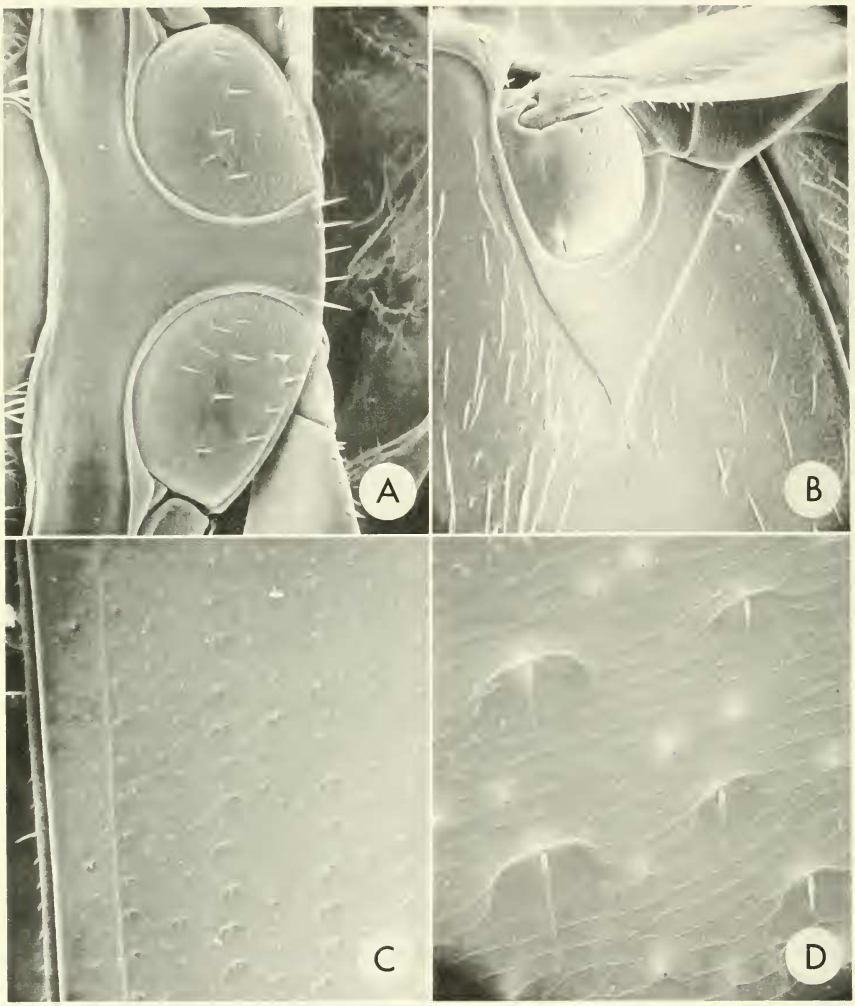


Fig. 1. *Acylomus pugetanus,* adult structures, scanning electron micrographs. A, Prosternal process and front coxae. 235×. B, Left mesocoxa and mesosternal plate. 200×. C, Dorsal surface of right elytron showing sutural edge, stria and microsculpture. 220×. D, Detail of dorsal elytral microsculpture and setae. 1100×.

ing. The presence and number of setae apparently are important in separating species of *Acylomus.*

The dorsal coloration is usually black or nearly so, but teneral specimens or thoroughly degreased, dry specimens may appear more brownish. The unique type specimen (data below) has a much paler

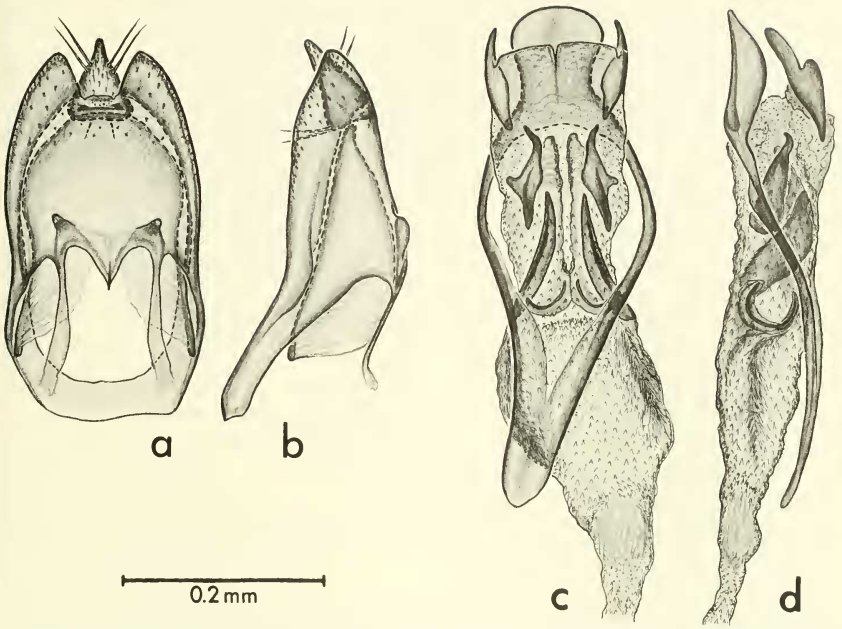


Fig. 2. *Acylomus pugetanus,* male genitalia. a–b, Basal piece and parameres, dorsal and lateral view. c–d, Median lobe, dorsal and lateral view.

brownish coloration than is normal; it apparently has faded with age since Casey (1916) described the color as "blackish-piceous."

Diagnostic characters.—In addition to the distinctive form of the male genitalia, the following combination of external features will distinguish *A. pugetanus* from other described U.S. species: Blackish dorsally and very dark ventrally, with areas of metasternum and femora darker than other parts of the venter; form of the prosternal process; sharply angulate mesosternal side plates; lack of sexual dimorphism in hind tibiae (males in some other species have tibiae broadly expanded at apex and enlarged apical spurs).

Type data.—The unique type specimen has only the label "W. T." as a locality, with Casey's dot code. With the description Casey gave "Washington State (Tacoma), Wickham" for the locality and collector, but Tacoma is not the locality given for the label code on the specimen. The pin partially obscures one of the code dots which indicates "N. Yakima," not Tacoma, as the locality, according to Casey's code list. The true type locality is probably North Yakima, Washington.

The specimen is in the Casey collection in the U.S. National Museum of Natural History, Smithsonian Institution, Washington, D.C., and is identified with the type number 48994 on a red label, and Casey's handwritten label "*pugetanus.*"

Remarks.—In his redefinition of the genus, Casey (1916) stated that the enlarged hind tibiae and spurs in male *Acylomus*

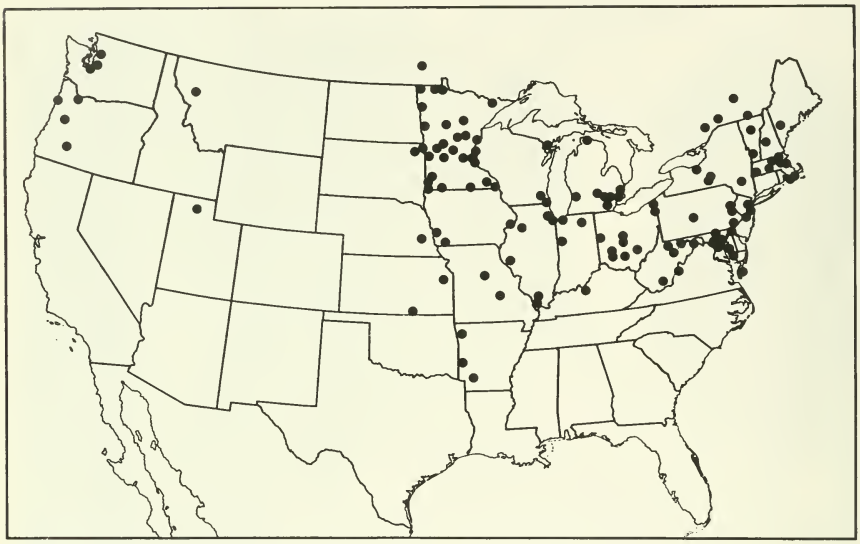

Fig. 3. *Acylomus pugetanus,* known distribution.

members were typical of the genus; genitalia were not studied by Casey. Because of this, he identified the type of *A. pugetanus* as a female. Upon dissection, this specimen was found to be a male, with genitalic structures identical to those of specimens found throughout the known range (Fig. 3; listed below). Prior to this discovery, and because the type specimen of *A. pugetanus* is brown, specimens recently collected were thought to belong to a separate, undescribed species.

Casey must have been aware of some kind of association of *Acylomus* spp. with ergot, having named another common and widespread species *A. ergoti,* but he wrote nothing on phalacrid biology. At present, it is uncertain that *A. ergoti* is associated with ergot. Some specimens earlier identified as *A. ergoti,* with labels referring to ergot association, were found to be *A. pugetanus,* while no specimens of *A. ergoti* examined bear biological data referring to ergot. Past references to *A. ergoti* (e.g. Lewis, 1945) may have been based on misidentifications and actually involved *A. pugetanus.*

Specimens examined and data.—Numbers in parentheses refer to the number of specimens from each locality and date. Any additional label data regarding habitat or method of collection are quoted verbatim, following the name of collector.

CANADA: MANITOBA: Husavick, 5 July 1915 (1), H. C. Fall. ONTARIO: Carleton Co.: Ottawa, 24 May 1955 (3), 21 Aug. 1956 (1), 13 Aug. 1958 (3), M. H. Hatch; Aug. 1980 (5), C. Young. QUEBEC: Berthier Co.: Berthi, 6 Sept. 1921 (2), F. T. Scott; Brome Co.: Knowlton, 21 Aug. 1956 (1), M. H. Hatch; Deux Montagnes Co.: St. Placide, 10 July 1931 (1), H. C. Fall; Rimouski Co.: Rimouski, Aug. 1936 (3), H. C. Fall. U.S.A.: ARKANSAS: Hempstead Co.: Hope, 24 Nov. 1921 (1), H. C. Fall; Polk Co.: 21 Aug. 1928 (1), J. G. Shaw; Washington Co.: 7 Sept. 1961 (2), W. H. Whitcomb, "on ergot on rye"; state label

only: H. C. Fall (1). CONNECTICUT: New London Co.: Barn Island, 30 Jan. 1975 (1), L. E. Watrous, "leaf litter." DELAWARE: Newcastle Co.: Newark, 15 Sept. 1953 (2), C. A. Triplehorn. DISTRICT OF COLUMBIA: Washington, 30 May (1). ILLINOIS: Cook Co.: Chicago Heights, July 1969 (1), "light trap"; Du Page Co.: Wheaton, 6 June 1959 (1); Henry Co.: Annawan, Sauk Tr. St. Pk., 17 June 1975 (1), "at light"; Jo Daviess Co.: 6 mi. S of Stockton, 29 July–3 Aug. 1972 (3), Reaves & Hollander, "at light"; Ogle Co.: White Pines St. Pk., 24–25 June 1966 (2), R. Chevalier, "sweeping"; Pike Co.: Pittsfield, 27 June 1947 (2), 7 June 1948 (1), B. Cadwell; Union Co.: 22 July 1938 (1), W. F. Turner; Williamson Co.: Carterville, 6 Sept. 1958 (1), 22 Mar. 1959 (1), V. Cole. INDIANA: Benton Co.: Oxford (5); Kosciusko Co.: Winona L. (1), E. B. Williamson; La Porte Co.: Michigan City, 1 June 1972 (5), M. Prokop, "on beach." IOWA: Page Co.: Norwich, 22 Aug. (1), A. T. McClay; Pottawattamie Co.: 1 mi. W. Crescent, 21 Aug. 1970 (1), G. Godfrey & J. Ameel; Scott Co.: Davenport, May 1964 (1), S. Peck, "light." KANSAS: Douglas Co.: 21 Mar. 1929 (1), R. H. Beamer; no date (3), F. H. Snow; Lone Star Lake, 30 Sept. 1951 (1), P. J. Spangler; Sumner Co.: Wellington (3), E. J. Kelly. KENTUCKY: Hardin Co.: Fort Knox, 3 July 1952 (1), R. D. Alexander, "Light trap." MAINE: Oxford Co.: Paris, 9 July 1914 (1), C. A. Frost. MARYLAND: Baltimore Co.: Baltimore, 17 June 1909 (1), F. E. Blaisdell; Calvert Co.: Chesapeake Beach, 23 May 1970 (1), M. Druckenbrod, "UV Light"; Carroll Co.: Eldersburg, 9 June 1985 (8), W. E. Steiner & J. E. Lowry; Dorchester Co.: Crapo, 8 Sept. 1984 (35), W. E. Steiner & D. S. Bogar, "Reared from ergot sclerotia on *Spartina patens*"; Garrett Co.: 2 mi. E Keysers Ridge, 2500′, 18 June 1968 (2), S. Peck; Montgomery Co.: Gaithersburg, 6 June 1979 (1), W. E. Steiner; Potomac, Aug. 1972 (1), W. E. Steiner; Prince Georges Co.: Bowie, 1–7 July 1981 (2), R. F. Denno, "Malaise trap"; 4 July 1984 (11), W. E. Steiner, J. E. Lowry & G. L. Williams, "Reared from ergot sclerotia on *Festuca pratensis*"; College Park, 17 July 1970 (1), R. A. Belmont; 5 km SE Croom, 30 May 1986 (1), W. Steiner, S. Larcher, J. Swearingen; Talbot Co.: 3 km SE Easton (Seth Forest), 3 Aug. 1986 (1), W. E. Steiner, J. M. Hill, J. M. Swearingen; McDaniel (Wades Pt.), 1 June 1979 (2), 14 June 1980 (1), W. E. Steiner; Wittman, 28 July 1973 (2), 25 Aug. 1973 (1), 1 Sept. 1973 (1), 13 Sept. 1974 (1), 24 May 1975 (1), 25 July 1975 (5), 5 July 1976 (3), 28 Aug. 1976 (1), 25 June 1977 (1), 26 June 1977 (3), 1 July 1977 (8), 5 July 1977 (1), 11 May 1979 (1), 19 July 1980 (2), 6 Sept. 1980 (1), 1 Aug. 1981 (2), 8 Aug. 1981 (5), 9 Aug. 1981 (2), 13 Sept. 1981 (1), W. E. Steiner, "At blacklight near mixed forest, open fields and tidal creek"; 5 July 1982 (91), 12 July 1982 (40), W. E. Steiner, "In sclerotia of ergot on *Festuca pratensis*"; 28 July 1985 (13), W. E. Steiner, J. E. Lowry & G. L. Williams, "Reared from ergot sclerotia on *Festuca pratensis.*" MASSACHUSETTS: Berkshire Co.: Monterey, 9 July 1919 (2), C. A. Frost; Dukes Co.: Cuttyhunk Is., Elizabeth Is., 21 Aug. 1971 (3), C. T. Parsons, "Flowers of *Achillea*"; 17 Sept. 1972 (4), C. T. Parsons, "Sweeping *Solidago*"; Nashawena Is., Elizabeth Is., 11 July 1972 (2), C. T. Parsons; Penekise Is., Elizabeth Is., 30 Aug. 1971 (1), C. T. Parsons, "Beating *Acer platanoides*"; Hampshire Co.: Ware, 23 Aug. 1957 (1), C. A. Frost, "Flowers *Solidago*"; Middlesex Co.: Pickman area, Bedford, 7 Aug. 1974 (10), J. F. Lawrence, "*Claviceps purpurea*"; Belmont, 10 Aug. 1974 (11), J. F. Lawrence, "*Claviceps purpurea*"; Billerica, 7 Sept. 1944 (1), A. I. Bourne, "in grass heads"; 15 Sept. 1944 (6), A. I. Bourne, "In smutted seeds of grass"; Concord, June (4), A. Fenyes; Framingham, 20 Nov. 1943 (1), C. A. Frost, "sifting humus"; 24 Sept. 1958 (1), C. A. Frost; Holliston, 11 Aug. (1), 6–13 Sept. (3), N. Banks; Lowell, 20 July 1893 (2), H. C.

Fall; Natick, 17 Apr. 1937 (1), C. A. Frost, "sifting"; 19 Aug. 1945 (1), C. A. Frost; Sherborn, 15 Mar. 1925 (1), P. J. Darlington; Tyngsboro, 30–31 Aug. 1904 (17), F. Blanchard; Norfolk Co.: Milton, 26 July 1903 (1), P. G. Bolster; Suffolk Co.: W. Roxbury, 14 June 1908 (1), P. G. Bolster; Worcester Co.: Ashburnham, 17 July 1952 (8), M. H. Hatch. MICHIGAN: Allegan Co.: Aug. 1980 (22), B. P. Singh, "In sclerotia of ergot on rye"; Cheboygan Co.: 30 July 1929 (1), 28 July 1953 (1), H. B. Hungerford; 5 July 1935 (1), M. Sanderson, "Collected at light"; 26 July 1935 (1), L. R. Penner; Ingham Co.: East Lansing, 2 Aug. 1979 (2), B. P. Singh, "In sclerotia of ergot on wheat"; 1 Aug. 1980 (24), B. P. Singh, "In sclerotia of ergot on rye"; Livingston Co.: E. S. George Reserve, 20 June 1939 (11), I. J. Cantrall; 8 July 1955 (1), M. L. Cantrall, "On flowers *Daucus carota*"; Whitmore Lake, 10 Aug. 1956 (2), G. H. Nelson; Macomb Co.: Selfridge Field, Mt. Clemens, 15–21 June 1944 (3), B. Malkin; Menominee Co.: Lake Mary, 8 July 1940 (1), I. J. Cantrall; Oakland Co.: Birmingham, 6 Aug. 1936 (1), M. H. Hatch; Milford, 21 May 1922 (1), T. H. Hubbell; Rochester, 10 July 1936 (1), M. H. Hatch; St. Clair Co.: Memphis, 16 Aug. 1979 (13), B. P. Singh, "In sclerotia of ergot on wheat"; 9 Oct. 1979 (46), B. P. Singh, "In sclerotia of ergot on quack grass, *Agropyron repens*"; 9 Oct. 1979 (9), B. P. Singh, "In sclerotia of ergot on rye"; Washtenaw Co.: 20 Aug. 1921 (4), 1 Aug. 1922 (1), M. H. Hatch; Locality and date unknown: "Mich. E.P.A.," F. Blanchard (1). MINNESOTA: Aitkin Co.: Tamarack, 3 July 1936 (1), H. R. Dodge; 24 June & 12 July 1973 (4), D. E. Rau; Anoka Co.: 23 June 1936 (1), H. R. Dodge; Chisago Co.: (1), O. W. Oestlund; Clay Co.: Buffalo River St. Pk., 11 June–20 Aug. 1972 (6), E. F. Cook, "N. J. Mosquito trap"; 26 July–9 Oct. 1973 (7), "Malaise Trap"; Crow Wing Co.: Crow Wing St. Pk., 20 July 1972 (1), E. F. Cook, "N. J. Mosquito Trap"; Douglas Co.: Brandon, 22 Aug. 1922 (1), Wm. E. Hoffmann; Freeborn Co.: Helmer Myre St. Pk., 30 May–14 Aug. 1972 (19), E. F. Cook, "N. J. Mosquito trap"; Houston Co.: Beaver Creek Valley St. Pk., 2–8 July 1972 (1), "N. J. Mosquito trap"; 16–22 July 1972 (1), E. F. Cook, "N. J. Mosquito trap"; 23 May–2 Oct. 1973 (58), "Malaise trap"; Houston Co.: La Crescent, 2 July 1956 (6), C. S. Li; SE tip of Houston Co., 23 May 1936 (1), H. R. Dodge; 31 Aug. 1936 (1), H. R. Dodge; Hubbard Co.: Lower La Salle L., 2–24 July 1971 (4), E. F. Cook, "N. J. Mosquito trap"; Itasca Co.: Grand Rapids N. Central Exp. Sta., 10 July–1 Aug. 1973 (19), "Malaise trap"; Itasca St. Pk., 22 June–8 July 1954 (10), C. S. Li; Itasca Park, 3 July 1939 (1), C. E. Mickel, "Light trap"; 13 July 1941 (3), H. P. Nicholson; Itasca Park, La Salle Valley, 9 July 1940 (3), C. E. Mickel, "at light"; Jackson Co.: Kilen Woods St. Pk., 13 June–11 Sept. 1972 (3), E. F. Cook, "N. J. Mosquito trap"; Kandiyohi Co.: Sibley St. Pk., 31 May–7 June 1974 (5), E. F. Cook, "Malaise trap"; Kittson Co.: Lake Bronson St. Pk., 7 June 1972 (1), "N. J. Mosquito trap"; Lac Qui Parle Co.: Lac Qui Parle St. Pk., 7 June–10 Sept. 1974 (15), E. F. Cook, "Malaise trap"; Marietta, 27 June 1921 (1), H. H. Knight; 5 mi. S Milan, 5 July 1974 (1), B. Tollefson; Lake Co.: Basswood Lake, Washington Id., 14–18 Aug. 1950 (1), J. W. Barnes & R. Namba; Lyon Co.: Camden St. Pk., 9 May–25 Sept. 1973 (30), "Malaise trap"; Olmsted Co.: 9 May 1905 (1), C. N. Ainslie; Pine Co.: Little Sand Ck., 1 mi. E Cloverdale, 4 July–11 Sept. 1973 (14), "Malaise trap"; Pipestone Co.: Pipestone Nat. Mon., 28 May 1973–9 Oct. 1974 (93), "Malaise trap"; Polk Co.: Red Lake River nr. Crookston, 6 June–27 Sept. 1973 (7), "Malaise trap"; Pope Co.: 30 July 1939 (1), C. E. Pederson; Glacial Lakes St. Pk., 12 Aug. 1972 (2), E. F. Cook, "N. J. Mosquito trap"; 31 May–19 Sept. 1973 (27), "Malaise trap"; Ramsey Co.: 9 Aug. 1922 (4), A. A. Nichol, "Ergot-rye"; 23 June 1936 (1), H. R. Dodge; Lake Vad-

nais, 18 Aug. 1956 (1); White Bear, 10 July 1921 (1), Wm. E. Hoffmann; Rock Co.: Blue Mounds St. Pk., 21 June 1973 (1), 23 Aug. 1973 (1), 30 Sept. 1973 (8), E. F. Cook; Roseau Co.: Roosevelt, 1 July 1964 (6), A. G. Peterson, "Bluegrass"; 8 mi. SE Roseau, 29 June 1961 (1), "ex Blue grass"; Stearns Co.: St. Anthony Pk., 5 June 1921 (1), Wm. E. Hoffmann; Swift Co.: 3 mi. SW Appleton, 4 July 1974 (1), B. Tollefson; Traverse Co.: 1 mi. NW Browns Valley, 12 June 1974 (1), B. Tollefson; 6 mi. NE Browns Valley, 19 June 1974 (3), B. Tollefson; Washington Co.: Valley Ck. nr. Afton, 18 June–21 July 1971 (4), "N. J. Mosquito trap"; Wright Co.: Buffalo, 30 July 1947 (2), S. I. Parfin. MISSOURI: Boone Co.: Columbia, 7 June 1970 (1), F. D. Parker, "Malaise trap 7AM–7AM"; Phelps Co.: Rolla, 24 June 1952 (4), M. H. Hatch; Rolla, Dry Fork Cr., 26 June 1950 (3), 27 May 1951 (4), H. Frizzell; 25 June 1952 (8), M. H. Hatch. MONTANA: Lake Co.: Moiese Nat. Bison Range, 17 June 1952 (1), M. H. Hatch. NEBRASKA: Lancaster Co.: Lincoln (4), F. M. Webster. NEW JERSEY: Hudson Co.: Arlington, 4 June (1); Middlesex Co.: Morgan, 4 May (1), Weiss & West; Monmouth Co.: Hornerstown, 14 May 1910 (1). NEW HAMPSHIRE: Grafton Co.: Rumney, 16 June 1924 (1), P. J. Darlington. NEW YORK: Essex Co.: Elizabethtown, July 1981 (1), A. E. Lacy; Tompkins Co.: Ithaca, Savage Farm, 5 Aug. 1968 (1), A. G. Wheeler, "Vernal Alfalfa"; McLean Bogs, 30 May 1919 (1), Inlet Brook, McLean Res., 22 May 1925 (1); Ulster Co.: Oliverea, 12 July 1919 (1), E. Shoemaker; Slide Mt., Catskills, 19 June 1918 (1); Wayne Co.: 14–17 Sept. 1948 (3), E. Shoemaker. OHIO: Ashtabula Co.: Andover (2), F. M. Webster; Clinton Co.: 18 May 1963 (1), F. J. Moore; Delaware Co.: 2 June (1), 3 Sept. 1957 (2), D. J. & J. N. Knull; Franklin Co.: 25 May 1963 (1), F. J. Moore; Columbus, 1957 (1), L. Schramm; Greene Co.: 12 May (2), 2 June (1), 18 May 1959 (1), D. J. & J. N. Knull; Hocking Co.: 20 May (1), 15 Sept. 1958 (1), D. J. & J. N. Knull; Mercer Co.: 5 July (1), T. H. Parks, "from ergot"; Ross Co.: Tar Hollow St. For., 16 Feb. 1976 (1), L. E. Watrous, "Berlese pine duff"; Trumbull Co.: Hubbard, 16–17 June 1975 (1), A. Newton & M. Thayer, "on flowers & vegetation." OREGON: Benton Co.: 12 mi. S Corvallis, 13 March 1949 (2), V. Roth, "in moss"; Jackson Co.: Prospect, 5 May 1939 (1), A. T. McClay; Multnomah Co.: Portland, 6 June 1915 (1), A. K. Fisher; Tillamook Co.: Sandlake, 5 July 1939 (1), K. M. & D. M. Fender. PENNSYLVANIA: Delaware Co.: 20 June 1894 (2), Geo. M. Greene; Huntingdon Co.: Furnace, 11 Aug. 1974 (7), D. Lambert, "ergot on rye"; Monroe Co.: Effort, 6 Aug. 1930 (7), 2 July 1939 (2), J. W. Green; Northampton Co.: Easton, 4 July 1926 (3), 30 June 1947 (1), J. W. Green. SOUTH DAKOTA: Roberts Co.: 12 mi. SE Sisseton, Lk. Traverse, 24 June 1974 (1), 19 July 1974 (3), B. Tollefson. UTAH: Box Elder Co.: Mouth Bear River, 17 July 1914 (2), A. Wetmore. VERMONT: Bennington Co.: East Dorset, 22 July 1935 (1), C. T. Parsons; Manchester, 25 June 1970 (1), C. T. Parsons, "black light"; Lamoille Co.: Stowe, 22 July 1981 (1). VIRGINIA: Accomack Co.: Wachapreague (Parramore I.), 19 May 1975 (1), W. E. Steiner, "in sweep of dune grasses"; Bath Co.: Blowing Springs Rec. Area, 7 July 1973 (1), M. Druckenbrod, "Beatg."; Warren Co.: 3 July 1973 (2), M. Druckenbrod, "Beating." WASHINGTON: King Co.: North Bend, 1 Sept. 1940 (2), M. H. Hatch; Snohomish Co.: Silver Lake, 20 July 1939 (1). WEST VIRGINIA: Hampshire Co.: 8 km NW Capon Bridge, Buffalo Gap Camp, 12–14 Sept. 1986 (1), W. E. Steiner & J. M. Swearingen, "At black light, edge of mixed forest, sandy soil slope"; Marion Co.: Fairmont, 1929 (5), Musgrave; Randolph Co.: Spruce Knob Mtn., 6 July 1973 (1), M. Druckenbrod, "Beatg."; Summers Co.: 5 km NE Talcott at Greenbrier River, 30 May 1982 (8), Steiner & Collins, "At light." WISCONSIN:

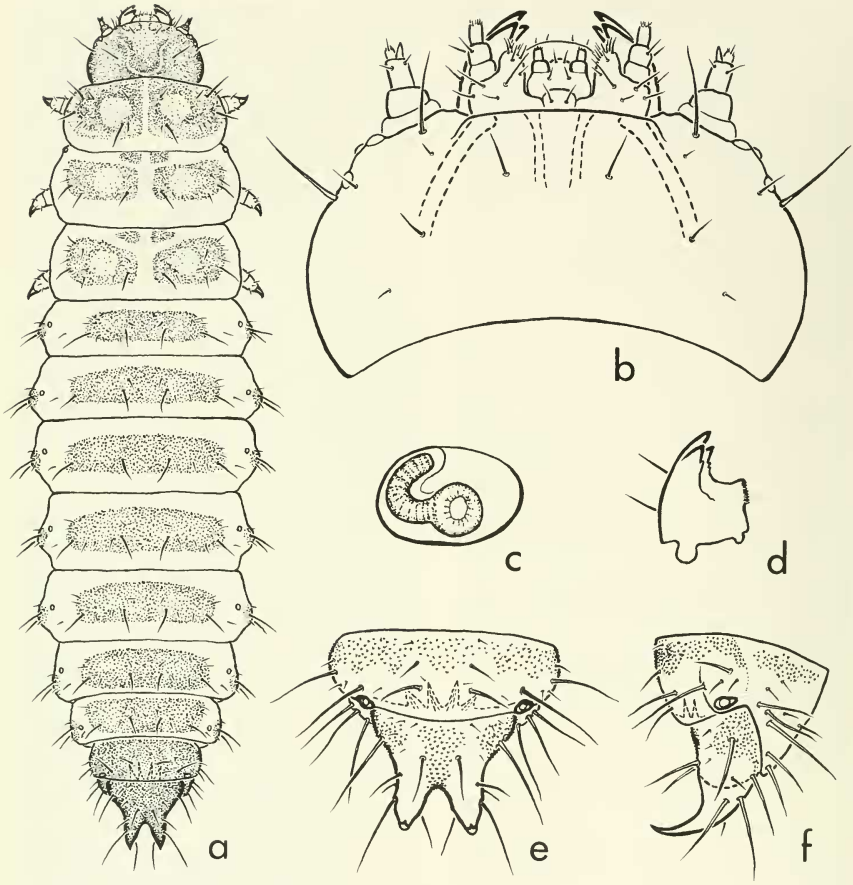


Fig. 4. *Acylomus pugetanus,* mature larva. a, Dorsal habitus. b, Ventral view of head. c, Abdominal spiracle. d, Right mandible, ventral view. e–f, Abdominal apex, dorsal and lateral view. Length of larva 3.5 mm.

Kenosha Co.: Chiwaukee Prairie, 3 Sept. 1967 (1), W. Suter, "sweep"; Waukesha Co.: Dousman, 11 June 1959 (2).

***Acylomus pugetanus,*** Mature Larva

Description.—Length 3.0–3.6 mm; width of head capsule 0.4–0.45 mm; body elongate, somewhat flattened dorsoventrally; head prognathous. Color whitish, with sclerotized parts (head, thoracic and abdominal sclerites, urogomphi, legs, spiracles) brownish; dorsal sclerites, especially on thorax, with lighter pigmented areas laterally; sclerites with setae of varying size, arranged as illustrated (Fig. 4a); some surfaces finely granular.

Head robust, wider than long, with dorsal outline nearly semicircular; large dorsolat-

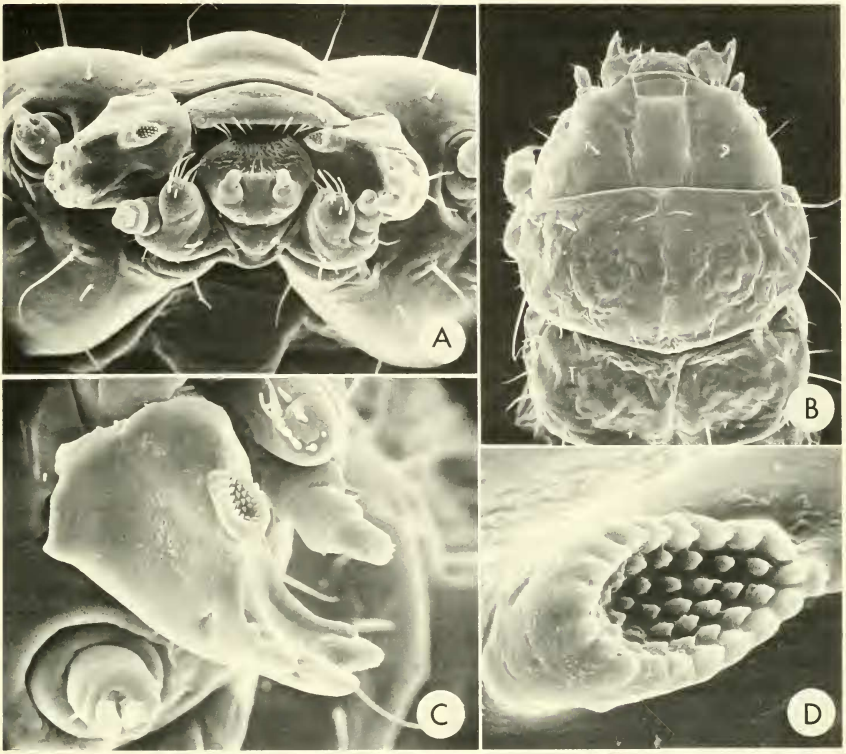


Fig. 5. *Acylomus pugetanus*, mature larva, scanning electron micrographs. A, Mouthparts, anterior view, with right mandible partially broken out. 266×. B, Head and prothorax, dorsal view. 92×. C, right mandible, dorsal view. 550×. D, Mola of right mandible. 2100×.

eral, lateral and ventrolateral setae as illustrated (Figs. 4a, 4b, 5b); a cluster of six ocelli on each side of head immediately posterior to antennae, with dark pigment spots beneath them; epicranial suture not pigmented, lyriform, with stem absent. Antennae very short, 3-segmented; 1st segment wider than long, resting loosely on a membranous base; 2nd segment cylindrical, slightly longer than wide, with 2 small subapical setae and an apical, conical accessory process; 3rd segment very small, as long as accessory process, cylindrical, with setae and sensillae apically. Mandibles (Figs. 4d, 5A–D) short, robust, heavily sclerotized, palmate, with 3 apical teeth, the middle one most prominent; smaller accessory teeth on inner edges of dorsal and ventral teeth; pseudomola prominent, well developed, with a concave, toothed, grinding surface; basal molar area smooth; 2 setae on lateral surface of mandible. Labrum transverse, broadly rounded anteriorly, with a few small setae along apical edge. Maxillae with cardo, stipes and mala fused, stout, setose as illustrated (Fig. 4b); palpi 3-segmented, nearly as long as

antennae. Labium with mentum small, bisetose; prementum broad, with 2 setae ventrolaterally; ligula short, rounded, with 2 apical setae; palpi short, 2-segmented.

Thoracic segments with dorsal sclerites not pigmented along midline; with small accessory sclerites anterior to these on meso- and metathorax; legs robust, short, with a few scattered, small setae; tarsunguli sharply, finely pointed. Abdominal segments 1–7 with dorsal sclerites broad, trapezoidal to oblong; lateral sclerites small; ventral sclerites of basal segments lightly sclerotized, becoming much more hardened and pigmented on posterior segment; 8th abdominal segment heavily sclerotized except for narrow lateral division between tergum and sternum; 9th segment completely, darkly sclerotized, with roughly granular areas medially and laterally; urogomphi strongly upturned, with sharply pointed apices (Fig. 4e, f); dorsal articulation between abdominal segments 8 and 9 internally with 4 anteriorly directed, darkly sclerotized, pointed spicules (visible beneath the integument). Spiracles on mesothorax and abdominal segments 1–8; openings annular, with a curved lateral duct (Fig. 4c).

Variation.—The extent of darkness of the sclerotized parts of the body is variable; this may be because of the age of the larva since the last molt. Setae vary in size and exact placement among individuals, and the smaller setae (e.g. on dorsum of abdomen) may vary in number. In larvae in the prepupal stage, the head assumes a hypognathous position because the thoracic segments become arched dorsally.

### *Acylomus pugetanus,* Pupa

Description.—Length including urogomphi 2.4–2.5 mm; width 1.2–1.3 mm; body white, eyes often darker (reddish to black, depending on age); larger setae light brown; body form oval, convex and arched dorsally, with head hidden in dorsal view; body with many long setae, as illustrated (Fig. 6a–c); setae stiff, erect, finely tapered.

Head with 6 setae on each side of frons and 1 above (on) each eye; a posterolateral seta usually much larger than others; clypeus with 4 small, inconspicuous setae along edge; 2 larger setae on labrum, and 1 on each mandible; palpi directed posteriorly, parallel with body midline; antennae partially hidden, lying beneath front femora, with apices between elytra and hind angles of pronotum.

Pronotum heavily setose dorsally except on midline; 1 seta on each side above front angle of pronotum much larger than others; 2 ventral setae arising medial to lateral margin, directed mesally. Mesothorax dorsally with 3 small setae in a triangular arrangement on each side; metathorax with 5 setae on each side, as illustrated (Fig. 6c). Elytra nearly meeting each other ventrally; surfaces smooth, with shallow longitudinal striae; a single seta near middle of basal ⅕ of each elytron; hind wings completely hidden beneath elytra.

Front and middle legs in a similar position, with femora and tibiae oriented obliquely to midline; femora each with 3 setae on apex and a row of 3 setae along anterior face. Hind legs not setose, hidden beneath elytra except for tips of tarsi.

Abdomen with setae small, inconspicuous dorsally, larger and more prominent laterally, with a larger seta at posterior corners of each of segments 1–6; each side of segment 8 with an extremely long, prominent seta laterally; segment 9 without setae, urogomphi not sclerotized, with finely tapered, slightly upturned and divergent apices. Genital segment in male (Fig. 6d) transverse, twice as wide as long, with a central transverse groove; in female (Fig. 6e) with 2 rounded papillae with short tips directed posterolaterally. Spiracles on abdominal segments 1–7 annular, inconspicuous; spiracle on segment 8 very small, vestigial.

Variation.—Number, size and placement of setae, particularly on the dorsum, varied slightly among individuals of the series examined; the single elytral seta is often ab-

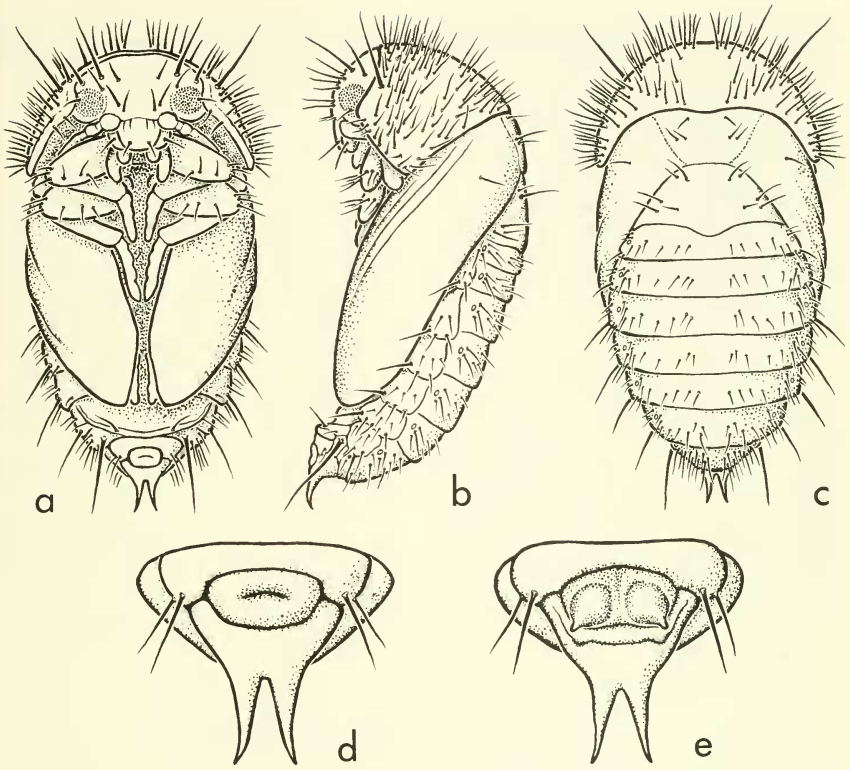


Fig. 6. *Acylomus pugetanus,* pupa. a, b and c, Ventral, lateral and dorsal views respectively. d, Ventral abdominal apex of male and, e, Female. Length of pupa 2.5 mm.

sent. Smaller setae apparently vary in number more often than the larger "key" setae. The largest setae on the head, pronotum, and sides of the abdomen, and those of the femora, are apparently constant in number and placement.

Remarks.—Pupal specimens have the larval exuvium attached to the apex of the abdomen; this conceals the urogomphi, genital segment, and the long setae of segment 8.

Larval and pupal material examined.—MARYLAND: Talbot Co.: Wittman, 5 July 1982 (16 L, 6 P), 12 July 1982 (3 L), W. E. Steiner, "In sclerotia of ergot on *Festuca pratensis*"; 28 July 1985 (13), W. E. Steiner, J. E. Lowry & G. L. Williams, "Reared from ergot sclerotia on *Festuca pratensis*." MICHIGAN: Allegan Co.: Aug. 1980 (14 L, 13 P), B. P. Singh, "in sclerotia of ergot on rye"; Ingham Co.: East Lansing, 2 Aug. 1979 (3 L, 1 P), B. P. Singh, "in sclerotia of ergot on wheat"; 8 Aug. 1980 (21 L, 25 P), B. P. Singh, "in sclerotia of ergot on rye"; St. Clair Co.: Memphis, 16 Aug. 1979 (6 L, 6 P), B. P. Singh, "in sclerotia of ergot on wheat"; 9 Oct. 1979 (1 L, 10 P), B. P. Singh, "in sclerotia of ergot on quack grass, *Agro-*

*pyron repens*." PENNSYLVANIA: Huntingdon Co.: Furnace, 11 Aug. 1974 (4 L, 6 P), D. Lambert, "ergot on rye."

Larvae and pupae were found in association with adult *A. pugetanus* in all of the above collections, and in several cases larvae and pupae were reared to the adult stage in the laboratory to confirm their identity.

Specimens of larvae and pupae are preserved in alcohol; a few larvae were cleared and kept in glycerine. The material is in the USNMNH collection, Smithsonian Institution, Washington, D.C.

## Biology and Discussion

Life cycle and feeding habits.—*Acylomus pugetanus* has been found feeding during the summer months on the sclerotia of ergot fungi (*Claviceps* spp.) on grains (wheat and rye), quack grass (*Agropyron repens* (L.) Beauv.), *Festuca pratensis* Huds., and *Spartina patens* (Ait.) Muhl. The sclerotia are eaten by both adults and larvae; gut contents of dissected adults and larvae were made up of only the dark fungal tissue. Larvae apparently consume more of the fungal mass than adults because they develop inside the sclerotia and hollow them out as they feed.

Adult beetles lay their eggs on the surface of the sclerotium. Larval development time has not been closely studied, but is fairly rapid (1–2 weeks) and there are apparently 3 instars. Several larvae (up to 7 but usually 2–3) can develop in a single sclerotium. Pupal cells are formed inside the sclerotium and adults emerge in 2–3 weeks. The entire life cycle, then, takes roughly 1 month and occurs during late summer.

In early July 1982 near Wittman, Talbot County, Maryland, *A. pugetanus* adults, larvae and pupae were collected from sclerotia of ergot on grasses growing along the edge of corn and soybean fields and mixed forests. Most sclerotia were on *Festuca pratensis* and a few were found on *Agropyron repens*. Nearly all sclerotia examined were infested by *A. pugetanus*; adult beetles were emerging when sclerotia were collected and continued emerging until the end of July. Sclerotia were dissected to determine the number of beetles per sclerotium and extent of feeding. A total of 308 sclerotia from inflorescences of *F. pratensis* collected on 5 and 12 July were examined. Only 2 were intact (without feeding damage); 306 were at least partially eaten and usually contained a larva, pupa, newly eclosed adult or empty pupal cell of *A. pugetanus*. Ten of the sclerotia contained 2 individuals; all others infested (296) had produced only a single beetle. The small size of these sclerotia (2–5 mm long) probably is the reason for the lower number of beetles per sclerotium as compared to that in rye and wheat ergot. Most sclerotia were thoroughly hollowed out by the larval feeding but often the exposed tip of the sclerotium was left uneaten.

Period of activity.—In Pennsylvania, Lambert and McIlveen (1976) first noted adult *A. pugetanus* in mid June on rye and other grasses infested with ergot in the honeydew (infective conidial) stage; similarly in Michigan, beetles appeared on infested grasses at this stage. Adults were collected or seen from then until frost in mid September. In Maryland (Dorchester County, Crapo) beetles emerged until late September from ergot sclerotia collected 8 September 1984 on *Spartina patens*. At Wittman, Talbot County, Maryland, *A. pugetanus* specimens were collected at blacklight from 11 May to 13 September. The early appearance of adults in May and their presence until frost suggest that they overwinter as adults; a few other specimens labeled as being collected by sifting leaf litter and moss in the winter months further confirm this.

The number of generations per year has not been determined. If their development is dependent on the ergot disease cycle, it is likely that they are univoltine, but alternate hosts of the beetle (e.g. ergot on wild grasses) may also be involved and allow for multiple generations each summer. Singh (1981) has demonstrated the lack of host specificity in

*A. pugetanus,* but the total ergot and grass host range is unknown.

Disease relationships.—If *A. pugetanus* adults are in fact attracted to the conidial stage of ergot fungi, they could be an important vector of the disease. Beetles could easily pick up the sticky honeydew bearing the conidia and fly long distances to other susceptible flowering grasses, as well as infect other ovaries on the same inflorescence or adjacent plants. The lack of host specificity in the beetle would also facilitate the spread of the fungus from wild reservoir hosts to grain crops.

The active feeding on the sclerotia by adults and larvae, on the other hand, is potentially beneficial in reducing disease inoculum for the following year. In sclerotia heavily infested by *A. pugetanus,* percent germination and number of stromata produced were greatly reduced (Lambert and McIlveen, 1976). The value of *A. pugetanus* as a biological control agent has not been determined. The vector role of the beetle may outweigh the beneficial aspects of its feeding.

A systematic study to determine the number of *Acylomus* species, their distributions, host ranges, and biologies, is in progress. This will allow further studies on the relationships among species of *Acylomus, Claviceps,* and host grasses, which will aid in evaluating the agricultural importance of these beetles.

## Acknowledgments

This work was supported in part by a cooperative agreement between the University of Maryland and the Biosystematics and Beneficial Insects Institute, Agricultural Research Service, USDA. We thank the U.S. National Museum of Natural History, Smithsonian Institution, for providing work space and equipment. John M. Kingsolver, Systematic Entomology Laboratory, Agricultural Research Service, called our attention to specimens and literature. We also thank John M. Kingsolver, Lloyd Knutson, and Theodore J. Spilman for their encouragement and critical reviews of the manuscript.

We are indebted to the following institutions and curatorial staff for their generous loan of material used in this study: American Museum of Natural History, New York, New York (L. H. Herman); California Academy of Sciences, San Francisco, California (D. H. Kavanaugh); Division of Entomology and Parasitology, University of California, Berkeley, California (J. A. Chemsak); Department of Entomology, University of California, Davis, California (R. O. Schuster); Department of Entomology, Cornell University, Ithaca, New York (L. L. Pechuman, J. A. Schafrik); Division of Insects, Field Museum of Natural History, Chicago, Illinois (L. E. Watrous); Snow Entomological Museum, University of Kansas, Lawrence, Kansas (P. D. Ashlock); Los Angeles County Museum of Natural History, Los Angeles, California (C. L. Hogue); Museum of Zoology, University of Michigan, Ann Arbor, Michigan (L. Blumer, T. E. Moore); Department of Entomology, Fisheries and Wildlife, University of Minnesota, St. Paul, Minnesota (P. J. Clausen); Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts (A. F. Newton); Department of Entomology, Ohio State University, Columbus, Ohio (C. A. Triplehorn); Department of Entomology, Oregon State University, Corvallis, Oregon (G. L. Peters); U.S. National Museum of Natural History, Smithsonian Institution, Washington, D.C. (D. M. Anderson, J. M. Kingsolver).

## Literature Cited

Bargar, G. 1932. Ergot and Ergotism. Gurney and Jackson, London, Edinburgh, pp. 279–297.

Bove, F. J. 1970. The Story of Ergot. S. Karger, Basel (Switzerland), New York.

Casey, T. L. 1916. Some random studies among the Clavicornia. Memoirs on the Coleoptera 7(2): 35–292.

Lambert, D. H. and W. D. McIlveen. 1976. *Acylomus*

sp. infesting ergot sclerotia. Annals of the Entomological Society of America 69: 34.

Lewis, R. 1945. The field inoculation of rye with *Claviceps purpurea.* Phytopathology 35: 353–360.

Singh, B. P. 1981. A new species of insect that feeds on ergot sclerotia. Phytopathology 71: 255 (abstract).

Steiner, W. E., Jr. 1984. A review of the biology of phalacrid beetles, pp. 424–445. *In* Wheeler, Q. and M. Blackwell, eds. Fungus-Insect Relationships, Perspectives in Ecology and Evolution. Columbia University Press, New York.